W2 Course Review Form

1. Course Acronym, Number, and Title: CHEM 3420: Physical Chemistry II

2. Instructor Name: Marc Richard

3. Instructor Program/School: Chemistry/NAMS

4. **A minimum of 30% of the students' final grade** should be based on the quality of their writing **(required for a W2)**. What writing assignments will be given and how will they be weighted in the grade? Specifically, consider what assignments you may include that tend to be in one of these categories in terms of student time and/or expectations for polished work or weight of grade assigned:
   a. low stakes (e.g., journals, blog entries, online posts, in-class writing),
   b. middle stakes (e.g., reading responses, summaries, annotated bibliographies), or
   c. high stakes (e.g., research papers, final projects).

   60% of the course grade is based on writing assignments. The majority of these assignments are written reports of laboratory work. There a variety of styles of reports: summary reports (middle stakes) and formal reports (high stakes). Formal reports are modeled after scientific journal articles and students are provided with instruction as to the appropriate style and format. Students complete five summary reports and two full, formal lab reports. In addition, students also complete an independent laboratory project. This project includes several components: a written proposal, written final report (modeled after a journal article) and oral presentation (Powerpoint).

5. Explain how **a minimum of 15% of instructional time in class or online (minimum required for a W2)** will be spent engaging students in activities that are likely to improve students' writing; these activities might consist of student time-on-task through homework and/or in class. *This is not a comprehensive list, nor need any class include all.*

Students will be given clear written assignment descriptions along with a discussion of formal scientific writing during class. Students will read journal articles, which serve as models for the formal writing. Rubrics will be used to evaluate student work, and the rubrics will be available to students at the beginning of the semester. The independent project has several checkpoints where students will receive feedback and assistance.

Students will be provided with:

- **clear, written assignment descriptions**
- **instruction on written assignments through brief lecture/explanation**
- **instruction on written assignments through assigned reading (in a textbook, handbook, handout, or online)**
- **rubrics (in advance of final grading) that indicate how work will be graded**
- **constructive feedback from the instructor (oral or written) to all or most students on drafts of assignments in progress**

6. On which of the following characteristics of student writing will you comment/grade?
   - prewriting (brainstorms/outlines/freewrites)
   - **application of genre conventions**
   - **understanding & addressing audience**
   - **understanding & addressing purpose**
   - **synthesizing information from multiple sources**
   - **analyzing data/ideas/arguments**
   - **stating an appropriate thesis clearly**
   - idea development
   - writing introductions/conclusions
   - **organization**
   - **paragraph unity**
   - **supporting details**
   - integrating sources (paraphrasing/quoting/citing)
   - awareness of writing practices/processes/quality
   - citation methods MLA APA Chicago Other
   - **style**
   - **voice/tone/level of formality**
   - **grammar and syntax**
   - punctuation

Please explain how you will comment on/grade these elements.

Rubrics will be used to given overall feedback on writing assignments along with general comments (Blackboard). Additional written feedback will be provided directly on student papers to highlight specific areas for improvement or well-executed passages. Assignment grades will include portions for both style and content.

Other information the Advisory Council might find useful:

Writing Advisory Council:

Outcome:

Approved

Revise/resubmit with

Revise with Writing Across the Curriculum Coordinator or reconsider W2 application

Notes/Recommendations:

CHEM 3420: Physical Chemistry II

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Phone: 652-4368
E-mail: marc.richard@stockton.edu

Office Hours Mondays 12–1
Thursdays 2–4
By appointment: call or email and we can find a time to meet

Lecture MWF 8:30–9:45 AM

Labs Tuesday, 8:30-11:10 AM, USC 354

Textbook *Physical Chemistry: A Molecular Approach*, McQuarie, & Simon (*University Science Books*)

Experiments in Physical Chemistry, Garland, Nibler, and Shoemaker, 8$^{\text{th}}$ edition (*available on reserve in the library*)

Lab Manual *Physical Chemistry Lab Manual*, Spring 2014 Edition, Available in the bookstore for purchase.

Website Course materials are available on the course website at `http://blogs.stockton.edu/pchem`

The website will be the place to find announcements, lecture summaries & slides, homework, exams, and solutions. In addition, a series of podcasts will be available aimed at helping you review the important mathematics skills necessary for success in physical chemistry. Please check the site frequently for new materials and announcements.

Copyright or other restricted material will be posted on the course Blackboard site.

Course Goals

1. **Learning fundamental principles, generalizations, or theories (Program Competence)**
   Students will develop an understanding of quantum mechanics and its application to atomic and molecular structure. These concepts will be applied to spectroscopic techniques used to probe structure.
2. **Learning to apply course material to improve thinking, problem solving, and decisions (Program Competence, Critical Thinking)**
   Students will apply concepts from quantum mechanics to develop problem-solving expertise enabling the solving of both quantitative and qualitative problems. In addition, concepts from across physical chemistry will be utilized to complete experimental work in the laboratory.
3. **Developing skill in expressing oneself orally or in writing (Communication Skills)**
   Students will prepare scientific manuscripts using a variety of formats to report on experimental work from the laboratory. In addition, a written proposal, oral presentation, and final written report will be submitted detailing the student's independent project work. Writing assignments will be evaluated using rubrics posted on the course website.

Prerequisites Physical Chemistry I (3410) plus at least a total of six semesters of chemistry, physics and calculus courses (*One year of general chemistry plus one year of college physics and a semester of calculus are needed as a minimum for this course. A year of organic chemistry is also recommended and additional calculus would be helpful.*)

Procedures and Policies

Lecture

Regular attendance is important and expected. **Please arrive on time.** Late arrivals are disturbing for the entire class. The lecture will cover new material and sample/group problem solving. Since we will be doing problem solving during class, please bring your calculator with you. Mobile phones, pagers, and other sound-producing devices must be turned off or silenced during class meetings.

Laboratory

Attendance is mandatory. You must complete all laboratory assignments & reports in order to pass the course. No unexcused absences are permitted. If it is necessary to be absent from a regular lab period for important reasons, you must contact me in advance. Your ride leaving early on Tuesday during the week before Spring Break does not qualify as an important reason. You must wear goggles and shoes with closed toes (no sandals) at all times in the lab. No exceptions.

Homework

Homework will be posted on the course website on a regular basis. Homework will not be collected but a suggested completion date will be included on all assignments. Solutions will be posted after the suggested completion date.

Completing problems on your own or in groups is essential for learning physical chemistry. Watching someone else solve problems or reading the solutions will not prove to be an effective way to master the material in this course. Do not put off working on problems to just before exams. You must keep up with the problems in order to be successful in this course. Please come to class with questions on the current assignment or bring your questions to office hours.

Additional assignments may be handed out periodically during the semester. These assignments will be due on the indicated date.

Lab Reports

Read the general lab guidelines and advice on lab reports, data analysis, preparation of graphs, note keeping, etc. in the lab manual before your first lab and refresh your memory after a few weeks. There are examples for all of the above in the lab manual as well as help files online. Full lab reports are due in lab **two weeks** after completing an experiment. Summary (short) lab reports are due in lab **one week** after completing a lab. You will write full reports for Experiments 1 & 5. The remaining reports will be summary reports.

Late Policy

I realize that your semester will create some busy periods so you are given 10 days of extensions for **lab reports only**, which must be used in one-day units. These extension days include weekends. To use an extension, please write "# days extension used" on the title page. . However, I do not want to encourage procrastination, so beyond that I will have to reduce your lab report grade points by 25% for each day that the report is late.

Extension days can only be used until Monday, April 28. Beyond that date, all reports will be considered late and penalized accordingly.

Exams

There will be at most a total of three exams tentatively scheduled for **February 28, March 28, and April 23**. Our final exam class session as determined by the extended class schedule is on **Friday, May 2, 8:30–11am**.

Exams will cover lecture material and homework. Exams will emphasize concepts and understanding, so no need to memorize lots of equations. The format of the exams will be discussed in class.

I will grant permission to make up an exam if the absence is due to any of the following: (1) serious illness; (2) an order from the US Military; (3) officially representing the College; (4) death in the immediate family. All such instances will require documentation before a make-up exam will be given.

Academic Honesty

Collaboration is important part of learning, especially in the sciences. Working in groups to discuss homework and class material is encouraged. When turning in written work sources must be cited in the appropriate format. Remember, you cannot copy someone else's words even if you have a proper citation. Direct quotes are not appropriate in scientific writing.

Your written work must be your own. Handing in someone elses work as your own is cheating. Plagiarism will result in a grade of zero for the assignment. Please review the college's academic honesty policy available on the Academic Affairs website. **All incidents of academic dishonesty will be reported to the Office of the Provost as required by college policy.**

Other Issues

Students with disabilities who may need disability related classroom accommodations (or other considerations) for this course are encouraged to speak with the Learning Access Program, located in J-204 or by calling 652-4988.

Grading

Your written work for this course will receive numerical grades. Each component of the course will be weighted as follows:

Laboratory	35%
Exams	35%
Project	25%
Participation (Class/Lab)	5%

There are no set ranges for particular letter grades. The grading scale will depend in part on my assessment of the difficulty of exams and the final. The grading scale for students completing all course requirements will not be raised above the 90–100% = A-range, 80–90% = B-range, 70–80% = C-range, 60–70% = D-range scale. This means if you receive an overall percentage of 90% and complete all course requirements, you will get a grade in the A-range. If you have an overall percentage of 89% and you have completed all course requirements you will be guaranteed *at least a grade in the B-range*.

Tentative Course Outline

Here's a brief and tentative outline of the topics we will cover this term. There may be supplemental readings distributed throughout the term. The sequence of topics is tentative and I'll give you updated schedules along the way.

1. The Foundation
   (a) Properties of waves
   (b) From the classical to quantum world
   (c) Wave equations
2. Atoms and Atomic Structure
   (a) Hydrogen: atomic orbitals
   (b) Helium: adding another electron is trouble
   (c) Beyond helium: approximations and trends
   (d) Periodicity & atomic spectroscopy: exciting atoms
3. Molecules
   (a) Transitions: translation, rotation, and vibration, oh my!
   (b) Chemical bonding: from atomic to molecular orbitals
   (c) Spectroscopy: using transitions to talk to molecules
4. The Solid State
   (a) From molecules to solids
   (b) Solid state structures
   (c) Diffraction: communicating with solids
   (d) Structure-property relationship in solids

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CHEM 3420: Physical Chemistry II — Spring 2014

Laboratory Information and Organization

In addition to information on the course syllabus I have compiled this document to outline some organizational features of Physical Chemistry Laboraotry.

- Due to the heavy use of instrumentation in the laboratory component of the course, all lab work will be performed in teams of 2 (3 if necessary). Student groups are expected to work as a team to complete each assigned experiment and independent project. If issues with an individual's participation in a team arises, please see me as soon as possible.
- **All written reports are to be completed individually**. The format for each experimental report is detailed in the lab manual. Full reports should follow the format outlined in introductory material in the manual and is modeled after a chemistry journal article. Summary reports do not have a formal format, but should be constructed to the same standards in terms of writing style, data analysis, and data presentation.
- There is no set schedule to complete the experiments. You are responsible for completing the seven experiments outlined in the manual by the week of April 1 (at the latest). This format should give you time to work on other experiments and/or your project during "downtimes".

  You may complete the experiments in any order, but take note of the following:

  - Some experiments will require an entire lab period to complete and some can be done in a shorter amount of time. Details of suggested time requirements for each experiment are listed in the table on the back.
  - Several experiments require a specific piece of equipment that can only be used by a single group. In this case, sign-up sheets will be available and groups will be required to sign up in advance to use these instruments.
  - Some experiments allow synthesis and product analysis to be completed in different weeks, while others require immediate analysis.

  You are expected to use your time productively, allowing for additional work on your projects during the semester. Students in previous semesters have requested additional time to complete project work, beyond the last weeks of the semester. By working smart you should have ample time during the semester to begin project work, which can then be completed during the last four weeks of lab. The last four lab meetings are reserved for project work.
- Teams are required to check-out with me each week to discuss laboratory progress. A short summary form will be submitted at the end of lab each week to report on work done in lab during the current session and a brief plan for the next meeting. These forms will also serve to inform me of the completion of an experiment for the purposes of lab report submission (see the syllabus for information on lab report due dates).
- Teams are required to meet with me before the project proposal deadline (Friday, March 7) to discuss details of their proposal. I also suggest meeting with me before the February 19 topic deadline if you need help identifying a project.

Introductory Material

Laboratory Notebook

Everyone is required to have a bound notebook for use in the lab. Laboratory notebooks from previous classes are acceptable as long as their is sufficient space remaning. All experimental data and observations must be entered, at the time they are taken, in ink (pencil and felt-tip pen smudge and become illegible and are unacceptable), directly into a bound notebook. Loose pieces of paper used to record data are not permitted. Do not erase data or tear pages out of the notebook. If an analysis is discarded, cross or line it out. Begin a new page for each experiment, with date and title on it. A laboratory notebook is an official document in any research work. Emphasis should be on keeping it up to date, legible and well organized.

Reports

One of the most important and highly valued skills that you develop during your college education is the ability to communicate information, both in speech and in writing, clearly and concisely to another person. Whatever you are doing ten years from now, your success will depend on your ability to communicate.

As a result of the special nature of much of the equipment in this laboratory, only one set-up for most experiments is available. This means that the order in which the experiments are done will not necessarily follow the lecture material. In order that a student perform the experiments intelligently, quickly and with maximum benefit, preliminary reading will have to be done before coming to the laboratory.

Each experiment will be graded not only on the basis of the precision and accuracy of the results but also on the quality and content of the report. These reports are to be written in a good literary style and should follow the formats discussed in the introductory material and each experiment. Poor spelling and sloppy writing will not be tolerated.

You should be aware of several books that are useful references for report writing:

- The ACS Style Guide, A Manual for Authors and Editors, Janet S. Dodd (American Chemical Society, Washington, D. C., 1986).
- Style Manual, 3rd Edition, D. Hathwell and A. W. K. Metzner, Eds. (American Institute of Physics, New York, 1978).
- The Elements of Style, William Strunk, Jr. and E. B. White, 3rd Edition (Macmillan, New York, 1979).
- The Chemist's English, Robert Schoenfeld (VCH Verlagsgesellschaft, Weinheim, 1985).
- Handbook for Authors (American Chemical Society, Washington, D. C., 1978).

The style for lab reports is modeled after scientific journal articles. The lab report, like any scientific paper, should tell a story. The reader should understand why the experiment was performed, what are the underlying chemical principles, what you saw, what that means in terms of the chemistry, and what knowledge you have gained from the work. Scientific writing is very different than other forms of writing. When writing in science the goal is to get the point across is the most direct and concise way.

You may find it helpful to look in journals (such as Journal of Physical Chemistry, Journal of Chemical Physics, Chemical Physics Letters, Journal of Chemical Education, or Journal of the American Chemical Society) to see how published articles are formatted.

Lab report format

Your physical chemistry laboratory reports should be written in such a way that any chemist, not only your own instructor, could completely understand what you have done.

A laboratory report for this class should include:

1. Title page

   Title of experiment

   A Laboratory Report for CHEM 3420, Prof. Richard

   Performed by:

   Partner:

   Date performed: Date submitted:

   The Richard Stockton College of New Jersey

   Pomona, NJ

2. Abstract: On the title page, write a short paragraph summarizing: any key background information, the purpose/goal of the work, the results of your experiment (including quantitative results) and any significant conclusions. You should Include the most significant numerical results.

   The abstract is what people read first. When I go to the library to check out new journal articles, I use the abstract to decide if the entire paper is worth reading. It should be brief, not more than a paragraph. It needs to contain a statement about what the work entailed and highlight a few key results. Often, the abstract is the last part of the report that you write.

3. Introduction: This section should contain a clear description, in your own words, of the purpose of the experiment with background material sufficient to **place the purpose in context**. Based on your results you may want to raise certain questions that are answered by the experiment (As a side note, these should not be written in the form of a question). It should **not** contain results or details of the procedure and should motivate the experiment. This section should contain many of your cited works since it deals with background information.

4. Experimental: A summary of how the experiment was performed should be included. You need to write what you actually did. Do not copy directly from the manual. Note any significant deviations from the lab manuals procedure. Write for an audience of trained chemists. The section should be written in the PAST TENSE since it should describe what you did.

5. Results and Discussion:

   This is the meat of your report and should contain the following pieces. These do not necessarily need to be separate sections or presented in this order. You need to organize this part of your report in order to best tell the "story" of your experimental work. Often papers have a "Results and Discussion" section that combines both.

   - Results: This part should include all the relevant data in a clear and organized fashion (e.g. in tabular form). You should introduce all of your tables with text, perhaps pointing out what the reader should note in each table. Each table, figure, and equation should be numbered. Figures (i.e. graphs) are often a useful method for presenting your results. Each table or figure should be labeled and a contain a descriptive caption (e.g. Table 1. Titration curve of a mixture of hydrochloric acid and phosphoric acid). Any figures should be treated similarly. **Raw data should not be reported, but meaningful data should presented that tells part of the "story" that you detailed in your introduction. Tables and figures alone do not constitute "results", you must have a narrative that describes your results and references your tables and figures.**

   - Discussion: A discussion of your results is often integrated with the results themselves and should explain any agreement and/or disagreement between theory, your experimental results, and the literature values. Also comment on the appropriateness of the method and make suggestions for improvements in the method and/or calculations. Any results you present need to be discussed: why are they interesting? what do they mean? what can they tell you and what can't they tell you? **You cannot just put a table or figure in your report that detail results without some sort of discussion on the results themselves.**

   - Calculations and Error Analysis: When necessary, show how you calculate your results, giving literature references for both important equations and accepted values against which you wish to compare your values. Figures together with a calculation of your final experimental values can be used to put any numerical results numbers into perspective. Details of your calculations should not be included in the text but can be placed in an appendix.

     You are no longer in high school, where you may have gotten credit for listing as many sources of error as possible (major or absurdly minor). Now we want to discuss and *evaluate* the important sources only that are **consistent with your experimental observations.**

     "The reported value of a physical quantity has little meaning unless it is accompanied by a statement of its uncertainty." Report your final results together with the uncertainty based on the precision and repeatability (see Garland et al. for a complete description of error analysis) of the data obtained. (e.g., $\Delta H_{vap} = 40. \pm 3.$ kJ/mole). From the uncertainty in the measurements, you should be able to calculate an uncertainty in your final numbers. This uncertainty is not the same as the deviation from the literature value (that you should also report if a literature value is available).

6. Summary and Conclusions: Give a one or two paragraph overview of your work, specifically highlighting the main conclusions or findings that the reader should remember from your report. Do not introduce new ideas or results in this section.

7. References: All literature information specifically referred to in the written text or in numerical tables or used as general background in your Report must be accurately listed. A reader must not be left in doubt as to the origin of your information. For example:

   The sample of ethyl benzoate was dried in the manner suggested. The proton NMR spectrum of ethyl benzoate was recorded in the prescribed manner [2]. As there was insufficient deuterated compound to record a spectrum, the data of Jones and Smith [3] were used in calculating the results for that compound. The observed value of 12.5 Hz for the methyl proton-methylene proton coupling constant, J, is in satisfactory agreement with the literature value [4] of 12.9Hz.

   Sample References

   1. Modern Chemical Instrumentation (Chemistry 304), Laboratory Instructions, prepared by James F. Skinner, p. 18, 1988.

   2. Reference 1, p. 21.

   3. Laboratory results of Mary R. Jones '88 and David F. Smith '89.

   4. I. H. Williams, G. M. Maggiora, and R. L. Schowen, J. Amer. Chem. Soc. 102, 7831 (1980).

   5. Let them eat cake, University Science Books, http://www.uscibooks.com/mcqcake.htm, accessed 16-Aug-2005.

Common writing errors in scientific reports [1]

1. You should write in complete sentences, using present or past tense with a subject and a verb. Break up your writing with paragraphs. Use past tense for things you did. Use present tense for things that are still true now. (e.g., The data show...)

2. You should use a dictionary regularly.

3. Unfortunately, the preferred writing style in scientific reports varies significantly. Generalizing, organic chemists tend to prefer totally avoiding the first person (I or we) and often using passive voice. "The temperature was measured to be 32C." (Does not specify who took the temperature.)

   The editors in physical chemistry journals are trying to get people away from using passive voice and instead using more active voice where the subject of the verb is explicitly included in the sentence. However, physical chemists still disagree on how best to do this.

   One way is to rearrange your sentences, still avoiding I or we, but including the subject. This will satisfy almost everybody as long as the sentence does not become awkward.

   "The measured temperature was 32C." or "The temperature was 32C."

   Some people think it is acceptable to use "we" but not "I" (even if you alone did the action). Others feel that it is perfectly acceptable to use "I," as long as you don't use it in every single sentence.

   In all cases, do try to vary your writing by using different sentence constructions, particularly in the experimental section where it is easy to drone on monotonously.

4. You should minimize splitting infinitives: "to effectively measure" should be "to measure effectively".

5. You should eliminate unnecessary words: "The procedure was used in order to determine...." could be "The procedure was used to determine...." or even "The procedure served to determine...

6. You should avoid colloquial expressions: "The Cary 219" should be "The Cary 219 spectrophotometer."

7. "Absorption is a general word. "Absorbance = ϵlC (Beers Law). "Adsorption refers to something adhering to a surface.

8. "Data", like strata, phenomena and media, is a plural word. "The data are given in the table".

9. "Affect" is the action (the verb) and "effect" is the result (the noun). "The breeze in the room affected the experiment. "The effect of the breeze was to mess things up totally. ("Effect can also be a verb meaning "to bring about." "He effected a change in the law.")

10. Set equations apart from written text and assign numbers, written to the far right of equation.

11. Number all pages of your report.

Working with experimental data

Scientific notation, significant figures

It is customary in scientific work to write a number with the decimal point immediately to the right of the first nonzero digit and to indicate the magnitude of the number by an exponent. It is then understood that there is some uncertainty in the most right-hand digit, usually plus or minus 2. For example, 0.00000190 and 186,175.3 should be written as 1.90×10^{-6} and 1.861753×10^{5} with three and seven significant figures, respectively. A calculated result can have no more significant figures than the least number of significant figures found in a piece of data used to calculate the result. Remember that electronic calculators give extraneous digits.

Error analysis

"By errors we do not mean disasters or blunders - instructors will have their own treatment for students who perpetrate these. Instead, we use the term error to describe the unfortunate tendency of any actual experimental result to be different from the true value of the parameter being measured." [3]

There are two distinct but equally important goals in presenting a numerical result. The first involves an indication of the uncertainty inherent in your value and the second involves a comparison of your value with an accepted value for this quantity. The term "error" is loosely applied to both of these factors.

The first goal encompasses what is referred to as precision or the closeness of approach of a number of replicate results to the average value of these results in a series of measurements. Poor precision is associated with a wide scatter of the individual determinations about the average value. Some scientists make a further distinction between precision and repeatability. In this way, the precision denotes the quality of the measuring instrument whereas the repeatability reflects the different values (judgements) that one or more persons would obtain in attempting to use this instrument for successive readings. Inadequate control of experimental conditions, e.g., temperature, might also affect repeatability.

Formal Lab Report Grading Rubric

The format for formal lab reports is described in detail in the laboratory manual. There are additional materials posted on the course website to assist you in writing formal laboratory reports.

	4 – Exceptional	3 – Admirable	2 – Acceptable	1 – Poor	0 - Substandard	Score
Abstract	Clear, concise, and thorough summary including context, important results, and conclusions.	Refers to most of the major points, but some minor details are missing or not clearly explained	Misses one of more major parts of the results, context, or conclusions	Missing several majors aspects and merely repeats information from the introduction	None or unrelated	___X 2
Introduction	A cohesive, well-written summary (including all relevant chemistry) of the background material pertinent to the experiment with appropriate references. Places the purpose of the experiment in context.	Is nearly complete but does not provide context for minor points. Contains relevant information but fails to provide background for one aspect of the experiment, or certain information is not cohesive.	Certain major introductory points are missing (ex: background, theory, chemistry, context, etc.) or explanations are unclear and confusing. References are used properly.	Very little background information is provided and/or information is incorrect. No references are provided.	None or unrelated	___X 2
Experimental	Contains details on how the experiment was performed and the procedures followed. Written in the correct tense and omits information that can be assumed by peers (trained chemists)	Narrative includes most important experimental details but is missing one or more relevant pieces of information.	Missing several experimental details or some incorrect statements.	Several important experimental details are missing. Narrative is incorrect, illogical, or copied directly from the lab manual. Written in the incorrect tense.	None or unrelated	___
Results (Presentation of results, figures and tables)	All figures, graphs, and tables are numbered with appropriate captions. All tables, figures, etc. are explicitly mentioned in the text. Relevant experimental data are presented which are used in the discussion.	All figures, graphs, and tables are correctly drawn, but some have minor problems that could be still be improved. All data and associated figures, etc. are mentioned in the text. Most relevant data present.	Most figures, graphs, and tables are included, but some important or required features are missing. Certain data reported are not mentioned in the text or are missing. Captions are not descriptive or incomplete.	Figures, graphs, and tables are poorly constructed; have missing titles, captions or numbers. Certain data reported are not mentioned in the text. Important data missing.	None or unrelated	___X 2

Overriding criterion: If any portion of the report is identified as not being original and/or not done by the student, the paper will receive a zero and academic dishonesty charges will be filed.

	4 – Exceptional	3 – Admirable	2 – Acceptable	1 – Poor	0 - Substandard	Score
Discussion/ Conclusions	Demonstrates a logical, coherent working knowledge and understanding of important experimental concepts, forms appropriate conclusions based on interpretations of results, includes applications of and improvements in the experiment, references collected data and analysis, refers to the literature when appropriate, and demonstrates accountability by providing justification for any errors. Address all specific points or questions posed in the lab manual.	Demonstrates an understanding of the majority of important experimental concepts, forms conclusions based on results and/or analysis but either lacks proper interpretation, suggests inappropriate improvements in the experiment, refers to the literature insufficiently, or lacks overall justification of error. Address most of the specific points or questions posed in the lab manual.	While some of the results have been correctly interpreted and discussed, partial but incomplete understanding of results is still evident. Student fails to make one or two connections to underlying theory. Address some of the specific points or questions posed in the lab manual.	Does not demonstrate an understanding of the important experimental concepts, forms inaccurate conclusions, suggests inappropriate improvements in the experiment, refers to the literature insufficiently, and lacks overall justification of error. Address none of the specific points or questions posed in the lab manual.	None or unrelated	___ X 2
References	All sources (information and graphics) are accurately documented in ACS format.	All sources are accurately documented, but a few are not in ACS format. Some sources are not accurately documented.	All sources are accurately documented, but many are not in ACS format. Most sources are not directly cited in the text.	All sources are accurately documented but not directly cited in the text.	Sources are not documented nor directly cited in the text.	___
Overall Style and Organization	Appropriate as a piece of scientific writing. Words were chosen carefully and appropriately. Sentence structure was clear and easy to follow. Evidence the report was edited by the author to improve clarity and readability.	Minimal awkward phrasing or word choices. Report is easy to read and constructed properly. Evidence of editing.	Many passages are phrased poorly, contained awkward word choices, or many long sentences. Narrative is disorganized in many places. Tense not appropriate or not in agreement in several places.	Poorly organized narrative with frequent awkward phrases and poor word choices. Sentences are too long or short. Lacks cohesion, style and fluidity. Many instances of verb tenses not agreeing. No evidence of editing.	Incorrect format, style and organization.	___ X 2
Mechanics (grammar, spelling, etc.)	From a technical standpoint, the paper is free of spelling, punctuation, and grammatical errors	Less than three grammatical and/or spelling errors	Multiple grammatical and/or spelling errors.	Frequent spelling and grammatical errors. Visit to Writing Center strongly encouraged.	Extreme technical errors. Visit to Writing Center strongly encouraged.	___

Summary Lab Report Grading Rubric

Unlike formal lab reports, summary reports do not need to follow a particular format. However, they must be constructed to the same standards in terms of writing style, data analysis, and data presentation. Please be sure to address specific points or questions raised in the lab manual.

	4 – Exceptional	3 – Admirable	2 – Acceptable	1 – Poor	0 - Substandard	Score
Data and Analysis	Presented in a clear manner. Data tables and figures are constructed correctly. Raw data is not included. Important calculations are demonstrated. Error analysis included when appropriate.	Is nearly complete, but missing important table, figures, or calculations. Some tables/figure unclear or contain too much information (ex: raw data). Error analysis is present by incomplete.	Missing important data or analysis to support discussion. Tables or figures are missing/incomplete. Error analysis is incomplete and/or incorrect. Raw data is presented in addition to other figures/tables.	Missing several major results and/or analyses. No tables or figures. Only raw data included. No evidence of data analysis.	None or unrelated	X 2
Discussion	Written clearly and in the appropriate style. Data is used to support claims Addresses all the points and/or questions posed in the laboratory manual. Critical analysis of results is included. Comparison to literature results included when appropriate.	Written clearly but the style is not appropriate in some passages. Data is used to support claims. Addresses most of the questions/points raised in the lab manual. Analysis of results is present but lacks clarity. Some literature comparison is included.	Discussion is not clear and does not use data to support claims. Omits several points/questions posed in the lab manual. Minimal comparison to literature results.	Very little discussion of results and data is not used as support. Discussion is unclear and/or disorganized. Does not address points/questions posed in the lab manual. No comparison to literature results.	None or unrelated	X 2
Mechanics (grammar, spelling, etc.)	From a technical standpoint, the paper is free of spelling, punctuation, and grammatical errors	Less than three grammatical and/or spelling errors	Multiple grammatical and/or spelling errors.	Frequent spelling and grammatical errors. Visit to Writing Center strongly encouraged.	Extreme technical errors	
Overall Style and Organization	Appropriate as a piece of scientific writing. Report organized to tell the "story" of the experiments. References included when necessary.	Minimal awkward phrasing or word choices. Organization makes points clear but could be improved. References cited when appropriate.	Writing contains awkward phrases and word choices Disorganized in many places. Tense not appropriate or not in agreement in several places. Missing some references when necessary.	Poorly organized with frequent awkward phrases and poor word choices. Lacks cohesion, style and fluidity. Many instances of verb tenses not agreeing. No references included when required to cite sources.	Little evidence of any effort to construct a summary report.	

Overriding criterion: If any portion of the report is identified as not being original and/or not done by the student, the paper will receive a zero and academic dishonesty charges will be filed.

The Richard Stockton College of New Jersey
Chemistry Program, School of Natural Sciences and Mathematics
101 Vera King Farris Dr, Galloway, NJ

CHEM 3420: Physical Chemistry II — Spring 2014

Independent Projects

This project is intended to be a fun introduction to independent thinking and research. Students may work in pairs on projects. The object is for you to propose a question and investigate the answer. Several possible projects are suggested here; you are encouraged to develop your own ideas.

Most any topic related to the material covered in Physical Chemistry I and II is acceptable, as long as the instructor approves it in advance. By **Wednesday, February 19**, you should submit your topic for approval. A 2-3 page proposal/summary of your topic, with an additional page of at least 3 primary (not WWW) references, is due **Friday, March 7**. This document is 15% of the project grade. More details about the proposal format will be distributed in class. **Each research team is required to meet with me before the proposal submission deadline.**

The last four lab sessions will be dedicated to project work. In addition, you will time throughout the semester to work in the laboratory on your project, so do not wait until the end of the semester to begin. Please be aware that projects are limited by equipment and supply availability.

An 8–10 page paper (written individually) is due Friday, May 2 (our extended class day). You will also make a presentation to the class on that day. Additional information on the paper and presentation will be discussed in class.

Grades will be assigned on the basis of presentation, creativity, effort, completeness, relevance, and evidence that you have learned something new. Actual results are much less important than explanations and analyses. A few suggestions are listed below.

Extensions of existing laboratory experiments:

1. Kinetics of bromination of deuterated acetone
2. Kinetics of the halogenation of acetone with a different halogen or catalyst
3. Further characterization of biodiesel, biodiesel of other oils
4. Further exploration of the phase diagram of binary or ternary system, using DSC or other techniques
5. Other applications of bomb calormietry

"New" laboratory experiments:

1. Studies of the physical properties of macromolecules, micelles, polymers
2. Ternary phase diagrams (from Sime text)
3. Monomer/dimer equilibrium (from Sime text)
4. Study of oscillating chemical reactions
5. Enzyme kinetics or other kinetics experiments, including using NMR spectroscopy
6. Kinetics of photochromic substances
7. *pKa* of a weak acid (from Sime text)
8. A P-Chem experiment that interests you, such as one from "Experiments in Physical Chemistry" by Garland et al. (available on reserve) or other texts (see me for those)
9. A P-Chem experiment that interests you form a recent issue of *J. Chem. Ed* (available on-line, talk to me for possible suggestions)

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CHEM 3420: Physical Chemistry II

Independent Project — Writing Your Proposal

Now that you have your general project topic approved, you need to write a proposal for your experimental work. This part of the project assignment has several goals:

- To develop your skills at designing a research project and the associated experimental plan
- To continue your exposure to the primary scientific literature
- To develop your written communication skills

Writing a research proposal is quite common in chemistry as most funds for research come from various granting agencies (NSF, NIH, etc). These groups require the submission of an extensive document that details the proposed work and typically includes information about broad goals, background and context, the specific aims and how they will be achieved, and a discussion of the broader impacts of the proposed work. Agencies have different formats and criteria used to evaluate proposals.

For example, the NSF provides the following information to writers as to how proposals will be evaluated:

> When evaluating NSF proposals, reviewers will be asked to consider what the proposers want to do, why they want to do it, how they plan to do it, how they will know if they succeed, and what benefits could accrue if the project is successful. These issues apply both to the technical aspects of the proposal and the way in which the project may make broader contributions. To that end, reviewers will be asked to evaluate all proposals against two criteria:
>
> - **Intellectual Merit**: The Intellectual Merit criterion encompasses the potential to advance knowledge; and
> - **Broader Impacts**: The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.
>
> *From the NSF Grant Proposal Guide, January 2013 http://www.nsf.gov/publications*

The proposal you write will not be as extensive as an NSF proposal, but should communicate many of the items discussed above. As you write your proposal be sure to address the areas listed below. These do not have to be separate sections, but that is a possible way to organize your document.

- Title: Make your title as specific as possible but not too long or full or jargon. It should give a clear indication of the goals of the research and it should also convey the types of experiments used.
- Introduction & Context: You need to clearly state the overarching goal of your proposed project. What broad question or questions (not too many for the broad goal) are you trying to answer through your experimental work? Goals provide an overall philosophy and a concise statement of the purpose of the whole project.
- Background: You need to discuss previous work in this area. Are you building on a published experiment? Are there any previous results? This part of your proposal should contain the majority of your references.

- Objectives & Experimental Methods: You need to explicitly state specific aims (more focused questions you are trying to answer) and the associated experiment or experiments you are going to perform.

  Objectives or aims relate directly to the goals and say what you are going to do, but not how you are going to accomplish your goals. The experimental methods outline what experimental techniques you will be using, what materials you will use, instrumentation you will employ, etc. You do not need to include experimental details (i.e. concentrations of reagents, explicit procedures, etc.), but should give the reader an idea of what types of experiments you are going to do in the lab to address your goals. You may also want to include a rough timeline for your experimental work.

  If you are breaking your proposal up into sections, these two areas can be connected. For example, Specific Aim 1 and then experimental plan to address that goal, followed by Specific Aim 2 and the plan for that goal, etc. It is up to you to decide how to best present your proposed work. More than 1 or 2 specific aims are all that is required for a project of this duration.

- References: List all your cited references. You must have at least three non-internet references, but you may need to consult more. These references should be cited in the text of your proposal using the proper format (see the lab manual).

References used in developing this handout:

National Science Foundation. Grant Proposal Guide, January 2013. http://www.nsf.gov/pubs/policydocs/pappguide/nsf13001/gpgprint.pdf (accessed Jan 23, 2014).

Richard Stockton College of New Jersey Grants Office. Developing Project Objectives. http://intraweb.stockton.edu/eyos/page.cfm?siteID=92&pageID=45 (accessed Jan 23, 2014).

Oral Presentation Grading Rubric

Name: _____ **Overall Score:** /44

Nonverbal Skills	4 – Exceptional	3 – Admirable	2 – Acceptable	1 – Poor
Eye Contact	Holds attention of entire audience with the use of direct eye contact, seldom looking at notes or slides.	Consistent use of direct eye contact with audience, but still returns to notes.	Displayed minimal eye contact with audience, while reading mostly from notes.	No eye contact with audience, as entire report is read from note.
Body Language	Movements seem fluid and help the audience visualize.	Made movements or gestures that enhance articulation.	Very little movement or descriptive gestures.	No movement or descriptive gestures.
Poise	Displays relaxed, self-confident nature about self, with no-mistakes.	Makes minor mistakes, but quickly recovers from them; displays little or no tension.	Displays mild tension; has trouble recovering from mistakes.	Tension and nervousness is obvious; has trouble recovering from mistakes.

Verbal Skills	4 – Exceptional	3 – Admirable	2 – Acceptable	1 – Poor
Enthusiasm	Demonstrates a strong, positive feeling about topic during entire presentation	Occasionally shows positive feelings about topic	Shows some negativity toward topic presented.	Shows absolutely no interest in topic presented.
Speaking Skills	Uses a clear voice and speaks at a good pace so audience members can hear presentation. Does not read off slides.	Presenter's voice is clear. The pace is a little slow or fast at times. Most audience members can hear presentation.	Presenter's voice is low. The pace is much too rapid/slow. Audience members have difficulty hearing presentation.	Presenter mumbles, talks very fast, and speaks too quietly for a majority of students to hear & understand.

Timing	4 – Exceptional	3 – Admirable	2 – Acceptable	1 – Poor
Length of Presentation	Within two minutes of allotted time +/-.	Within four minutes of allotted time +/-.	Within six minutes of allotted time +/-	Too long or too short; ten or more minutes above or below allotted time.

Content	4 – Exceptional	3 – Admirable	2 – Acceptable	1 – Poor
Subject Knowledge	An abundance of material clearly related to the research is presented. Points are clearly made and evidence is used to support claims	Sufficient information with many good points made, uneven balance and little consistency.	There is a great deal of information that is not clearly integrated or connected to the research.	Goal of research unclear, information included that does not support research claims in any way.
Organization	Information is presented in a logical and interesting sequence which audience can follow. Flows well.	Information is presented in logical sequence which audience can follow.	Audience has difficulty following presentation because the presentation jumps around and lacks clear transitions.	Audience cannot understand presentation because there is no sequence of information.
Questions	Answers questions posed by the audience completely and thoroughly.	Questions from the audience are answered but there is hesitation or lack of completeness.	Questions are not answered fully and are not handled in acceptable manner.	Questions are not answered appropriately and handled unprofessionally
Visuals	Excellent visuals that are tied into the overall story of the research.	Appropriate visuals are used and explained by the speaker.	Visuals are used but not explained or put in context.	Little or no visuals, too much text on slides.
Mechanics	Presentation has no misspellings or grammatical errors.	Presentation has no more than two misspellings and/or grammatical errors.	Presentation has three misspellings and/or grammatical errors.	Presentation has many spelling and/or grammatical errors.

Comments: